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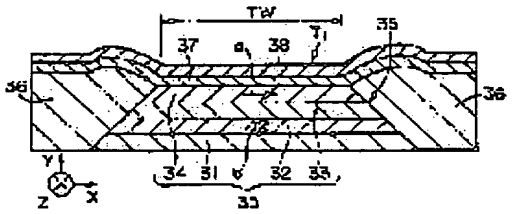
(54) MAGNETORESISTIVE-EFFECT MULTILAYERED FILM

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a magnetoresistive-effect type sensor, in which a layer for applying a vertical bias to a free ferromagnetic layer is formed in a shape such that the layer is laminated on the free ferromagnetic layer, the possibility of mixing an unnecessary element to a boundary section between the layer for applying the vertical bias to the free ferromagnetic layer and the free ferromagnetic layer is prevented, and an effect by the vertical bias can be obtained fully, which has superior linear response and in which Barkhausen noises are inhibited.
SOLUTION: This film T1 is formed by laminating a pinned ferromagnetic layer 32, in which magnetization inversion is pinned, and free ferromagnetic layer 34, in which magnetization inversion is made free, through a nonmagnetic layer 33. A soft magnetic layer 37 is laminated on the top face or the underside of the free ferromagnetic layer 34, and an anti-ferromagnetic layer 38 is laminated on the top face or the underside of the soft magnetic layer 37 by at least one layer.



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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] Magneto-resistive effect multilayers characterized by the pinning ferromagnetism layer to which pinning of the flux reversal was carried out, and flux reversal being the magneto-resistive effect multilayers which come to carry out the laminating of the freed free ferromagnetism layer through a non-magnetic layer, and the laminating of the soft magnetism layer being carried out to the top face or inferior surface of tongue of said free ferromagnetism layer, and coming to carry out the laminating of the antiferromagnetism layer to the top face or inferior surface of tongue of said soft magnetism layer further at least.
[Claim 2] They are the magneto-resistive effect multilayers which come to carry out the laminating of the free ferromagnetism layer by which the pinning ferromagnetism layer to which pinning of the flux reversal was carried out, and flux reversal were freed through a non-magnetic layer. The laminating of the soft magnetism layer which carries out ferromagnetic association to said free ferromagnetism layer, and lowers the coercive force of this free ferromagnetism layer is carried out to the top face or inferior surface of tongue of a free ferromagnetism layer. Magneto-resistive effect multilayers which carry out the laminating of the antiferromagnetism layer which single-domain-izes this soft magnetism layer on the top face or inferior surface of tongue of said soft magnetism layer further at least, and are characterized by being what measures and uses the electric resistance according to the magnetic reversal of said free ferromagnetism layer.
[Claim 3] Magneto-resistive effect multilayers according to claim 1 or 2 to which it consists of a crystal phase which consists of carbide with element M' which said soft magnetism layer becomes from one sort or two sorts or more of elements of the crystal phase which uses bccFe as a principal component, and Ti, Zr, Hf, V, Nb(s), Ta and W, and a nitride, and the diameter of average crystal grain is characterized by coming to make a fine crystal grain 30nm or less into a subject.
[Claim 4] Magneto-resistive effect multilayers according to claim 1 or 2 characterized by consisting of an amorphous phase which consists of a compound with the element M with which said soft magnetism layer is set to the crystal phase which makes a subject crystal grain of 30nm or less of diameters of average crystal grain which use bccFe as a principal component, and O from one sort or two sorts or more of elements of Ti, Zr, Hf, V, Nb, Ta, W, and the rare earth elements.
[Claim 5] Magneto-resistive effect multilayers according to claim 1 or 2 to which said antiferromagnetism layer is characterized by consisting of one sort of a Cr-aluminum system alloy, a Cr-Ga system alloy, a Cr-In system alloy, and NiO.
[Claim 6] Magneto-resistive effect multilayers according to claim 1 or 2 to which thickness of said soft magnetism layer is characterized by coming to make thickness of 100-300A and a free ferromagnetism layer sum total thickness of 80-90A, said antiferromagnetism layer, and a free ferromagnetism layer into 200-400A.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the magneto-resistive effect multilayers which constitute the magneto-resistive effect component applied to the magnetic head, a position sensor, a rotation sensor, etc.
[0002]
[Description of the Prior Art] Conventionally, the AMR (Anisotropic Magnetoresistance) head using the anisotropy magneto-resistive effect phenomenon as a magneto-resistive effect mold reading head (MR head) and the GMR (Giant Magnetoresistance: giant magneto-resistance) head using the spin dependence scattering phenomenon of conduction electron are known, and the spin bulb (Spin-Valve) head which shows a high magneto-resistive effect by the low external magnetic field is shown in the U.S. Pat. No. 5159513 specification as one example of a GMR head.
[0003] Drawing 4 shows an example of the spin bulb structure known conventionally, and the structure of this example carries out the laminating of the free ferromagnetism layer 1, the nonmagnetic interlayer 2, the pinning ferromagnetism layer 3, and the antiferromagnetism layer 4 on a substrate, it forms the magnet layers 5 and 5 which consist of Co-Pt etc. so that a layered product may be inserted into the both sides of this layered product, it forms the electrode layers 6 and 6 on it, and is constituted. In order to make the magnetization direction of the pinning ferromagnetism layer 3 fix to the Z direction of drawing 4 in structure conventionally which is shown in drawing 4 , a comparatively big bias field is required, and the more this bias field is large, the more it will be moreover, good. In order to overcome the anti-field of the Z direction of drawing 4 and for the magnetization direction not to shake by the magnetic flux from a magnetic medium, the bias field of 100 Oe is required at least. If it is in structure conventionally which is shown in drawing 4 in order to acquire this bias field, the exchange anisotropy field produced by contacting the antiferromagnetism layer 4 in the pinning ferromagnetism layer 3, and preparing it in it is used.
[0004] By the magnet layers 5 and 5, while making magnetization turned in the direction of a truck in the condition of having impressed parallel (the direction of X of drawing 4 : the direction of a truck) vertical bias to the free ferromagnetism layer 1 to the film surface as it is the structure shown in drawing 4 , and having single-domain-ized It is necessary to make it turn to the Z direction in drawing, where bias is impressed and single-domain-ized in the direction which intersects perpendicularly the magnetization direction of the pinning ferromagnetism layer 3 with the Z direction in drawing 4 , i.e., the magnetization direction of the free ferromagnetism layer 1. The purpose of the aforementioned vertical bias impression is for making it little smooth resistance change of a noise to this magnetic flux from controlling the Barkhausen noise produced when the free ferromagnetism layer 1 forms many magnetic domains, i.e., a magnetic medium. Moreover, when the magnetization direction of said pinning ferromagnetism layer 3 must not change and the direction of the free ferromagnetism layer 1 changes with the magnetic flux (Z direction of drawing 4) from a magnetic medium in the range of 90**theta** to the magnetization direction of the pinning ferromagnetism layer 3, the linearity responsibility of a magneto-resistive effect is acquired. As mentioned above, by using for the bias of the pinning ferromagnetism layer in the case of a spin valve head, and the vertical bias of a free ferromagnetism layer the exchange anisotropy field produced in a contact interface with an antiferromagnetism layer, linearity responsibility is good and the magneto-resistive effect mold head which controlled the Barkhausen noise is realized.
[0005]
[Problem(s) to be Solved by the Invention] The sense of magnetization of the truck close to the magnet layers 5 and 5 and the section (field show in drawing 4 with a sign 7) tended to become the insensible field which do not change easily, and if it be in the free ferromagnetism layer 1 to which vertical bias be impressed by the magnet layers 5 and 5 on either side, when further narrow track-ization accompanying improvement in the recording density of a magnetic medium be advanced, there be a possibility may produce a problem, in the spin bulb structure show in drawing 4 .

[0006] Then, previously, as shown in drawing 5 , invention-in-this-application persons formed the ferromagnetic layer 8 which consists of nickel-Fe etc. so that the layered product S which consists of the free ferromagnetism layer 1, the nonmagnetic interlayer 2, a pinning ferromagnetism layer 3, and an antiferromagnetism layer 4 might be inserted from the both sides, and have proposed the structure which carried out the laminating of the antiferromagnetism layer 9 and the electrode layer 10 on this ferromagnetic 8. According to this structure, by the one direction anisotropy of the antiferromagnetism layer 9, magnetic flux can be made to be able to act on the free ferromagnetism layer 1 side from the extension section 8a side of the ferromagnetic layer 8 which touches the layered product by single-domain-izing the ferromagnetic layer 8, and vertical bias can be magnetically impressed to the free ferromagnetism layer 1 by the exchange interaction by this.
[0007] However, in order to manufacture the laminated structure shown in drawing 5 After carrying out the laminating of the free ferromagnetism layer 1, the nonmagnetic interlayer 2, the pinning ferromagnetism layer 3, and the antiferromagnetism layer 4 Since the layered product S which has the width of face which performs processing by the photolithography technique in which put a mask only on the part which should be made into a layered product S, and ion milling removes other garbages, and is equivalent to the width of recording track is manufactured A possibility that the reattachment of an unnecessary element may happen to the periphery part of the obtained layered product S at the time of ion milling was high, the unnecessary element mixed in the important part on which magnetic flux is made to act in the part to which a layered product S contacts extension section 8a of the ferromagnetic layer 8, and there was a possibility that it might become impossible to acquire the effectiveness by desired vertical bias.
[0008] This invention by having been made in view of said situation and preparing the layer for impressing vertical bias to a free ferromagnetism layer in the form which carries out a laminating to the free ferromagnetism layer instead of the flank side of a free ferromagnetism layer While being able to abolish fear of unnecessary element mixing to the boundary part of the layer for impressing vertical bias to a free ferromagnetism layer, and a free ferromagnetism layer and fully being able to acquire the effectiveness by vertical bias It excels in linearity responsibility and aims at offering the magneto-resistive effect mold sensor which controlled the Barkhausen noise.

[0009]
[Means for Solving the Problem] In order that this invention may solve said technical problem, the pinning ferromagnetism layer to which pinning of the flux reversal was carried out, and flux reversal are the magneto-resistive effect multilayers which come to carry out the laminating of the freed free ferromagnetism layer through a non-magnetic layer, the laminating of the soft magnetism layer is carried out to the top face or inferior surface of tongue of said free ferromagnetism layer, and an antiferromagnetism layer is characterized by coming to carry out a laminating further at least on the top face or inferior surface of tongue of said soft magnetism layer. Next, they are the magneto-resistive effect multilayers which come to carry out the laminating of the free ferromagnetism layer by which the pinning ferromagnetism layer to which the focus stop of the flux reversal was carried out, and flux reversal were freed in this invention through a non-magnetic layer. The laminating of the soft magnetism layer which carries out ferromagnetic association to said free ferromagnetism layer, and lowers the coercive force of this free ferromagnetism layer is carried out to the top face or inferior surface of tongue of a free ferromagnetism layer. The laminating of the antiferromagnetism layer which single-domain-izes this soft magnetism layer on the top face or inferior surface of tongue of said soft magnetism layer is carried out further at least, and it is characterized by being what measures and uses the electric resistance according to the magnetic reversal of said free ferromagnetism layer. Furthermore, in this invention, it consists of a crystal phase which consists of carbide with element M' which said soft magnetism layer becomes from one sort or two sorts or more of elements of the crystal phase which uses bccFe as a principal component, and Ti, Zr, Hf, V, Nb(s), Ta and W, and a nitride, and the diameter of average crystal grain is characterized by coming to make a fine crystal grain 30nm or less into a subject.
[0010] In this invention structure, it is characterized by consisting of an amorphous phase which consists of a compound with the element M with which said soft magnetism layer is set to the crystal phase which makes a subject crystal grain of 30nm or less of diameters of average crystal grain which use bccFe as a principal component, and O from one sort or two sorts or more of elements of Ti, Zr, Hf, V, Nb, Ta, W, and the rare earth elements. It is desirable that said antiferromagnetism layer consists of one sort of a Cr-aluminum system alloy, a Cr-Ga system alloy, a Cr-In system alloy, and NiO. Moreover, it is desirable to come to make thickness of 100-300A and a free ferromagnetism layer sum total thickness of 80-90A, said antiferromagnetism layer, and a free ferromagnetism layer into 200-400A for the thickness of said soft magnetism layer.
[0011]
[Embodiment of the Invention] With reference to a drawing, one gestalt of this invention is explained below. Drawing 1 is what shows one gestalt of the magneto-resistive effect multilayers concerning this invention. On the ferromagnetic layer 31 for pinning formed on the substrate which constitutes the magnetic head of illustration abbreviation etc. The laminating of the pinning ferromagnetism layer 32, a non-magnetic layer 33, and the free

ferromagnetism layer 34 is carried out one by one, for example, the layered product 35 of cross-section trapezoidal shape is formed. The electrode layers 36 and 36 which open spacing equivalent to the width of recording track TW between mutual, and insert a layered product 35 into the both-ends side of the free ferromagnetism layer 34 from the both sides are formed. Moreover, the electrode layers 36 and 36 and the free ferromagnetism layer 34 are covered, the laminating of the soft magnetism layer 37 is carried out, on the soft magnetism layer 37, the soft magnetism layer 37 is covered and the laminating of the antiferromagnetism layer 38 is carried out. In addition, in the structure of this gestalt, the magneto-resistive effect multilayers T1 of a spin bulb mold are constituted by the ferromagnetic layer 31 for pinning, the pinning ferromagnetism layer 32, the non-magnetic layer 33, the free ferromagnetism layer 34, the soft magnetism layer 37, and the antiferromagnetism layer 38.

[0012] Said ferromagnetic layer 31 for pinning makes the magnetic switched connection force act on the pinning ferromagnetism layer 32 formed on it, and increases the coercive force of the ferromagnetic layer 32, and it is for carrying out pinning of the sense of magnetization, as for this ferromagnetic layer 31 for pinning, it is desirable to consist of the antiferromagnetic substance, especially the oxide antiferromagnetic substance, and it is formed from alpha-Fe 2O3 as one example. If it is the ferromagnetic layer 31 for pinning which consists of this alpha-Fe 2O3, since the Maureen point of 2Oalpha-Fe 3 the very thing is high and blocking temperature is high, after excelling in linearity responsibility, it is strong to a temperature change, and the magneto-resistive effect multilayers which can control a Barkhausen noise certainly can be offered. In addition, Pt-Mn, Ir-Mn, Fe-Mn, NiO, etc. can be used other than alpha-Fe 2O3. Although said ferromagnetic layers 32 and 34 all consist of a thin film of a ferromagnetic, they specifically consist of a nickel-Fe alloy, a Co-Fe alloy, a nickel-Co alloy, Co, a nickel-Fe-Co alloy, etc. Moreover, Co layer to the ferromagnetic layer 34 can also consist of a nickel-Fe alloy layer or a laminated structure of Co layer and a nickel-Fe alloy layer for the ferromagnetic layer 32. In addition, when considering as the two-layer structure of Co layer and a nickel-Fe alloy layer, it can also consider as the structure which arranges thin Co layer to a non-magnetic layer 33 side.

[0013] Possibility that factors other than spin dependence dispersion of conduction electron will arise is low, and it originates in the ability of a higher magneto-resistive effect to be acquired rather than the direction where the effectiveness of spin dependence dispersion of conduction electron constitutes a large thing and the ferromagnetic layers 32 and 34 from an ingredient of the same kind according to the interface of Co and Cu consists of ingredients of a different kind, if this is in the giant magneto-resistance developmental mechanics of the structure whose non-magnetic layer 33 is pinched in the ferromagnetic layers 32 and 34. Since it is such, when the ferromagnetic layer 32 is constituted from Co, the structure which permuted the non-magnetic layer 33 side of the ferromagnetic layer 34 by Co layer by predetermined thickness is desirable. Moreover, even if distinguish especially Co layer and it does not prepare it, it is good also as a concentration gradient layer to which Co concentration becomes thin gradually as it considers as the alloy condition of having included more Co(es) in the non-magnetic layer 33 side of the ferromagnetic layer 34 and goes to the opposite side.

[0014] Said non-magnetic layer 33 consists of non-magnetic material represented by Cu, Cr, Au, Ag, etc., and is formed in the thickness of 20-40A. If the thickness of a nonmagnetic membrane 33 is thinner than 20A here, magnetic association will become easy to take place between the ferromagnetic layer 32 and the ferromagnetic layer 34. Moreover, since the rate of the conduction electron scattered about by the interface of the non-magnetic layer 33 which is the factor which produces a magneto-resistive effect, and the ferromagnetic layers 32 and 34 will fall and a magneto-resistive effect will be reduced according to the shunt effect of a current if a non-magnetic layer 33 is thicker than 40A, it is not desirable.

[0015] Said soft magnetism layer 37 consists of film of the soft magnetism alloy explained below, and is preferably formed in about 100-300A in thickness. In addition, it is desirable to use the big thing of specific resistance while the soft magnetism layer 37 used here is excellent in soft magnetic characteristics and its saturation magnetic flux density is high.

[0016] FeaMbOc shows as example of presentation 1 empirical formula -- having -- M -- rare earth elements (Sc belonging to 3A group of a periodic table --) Y, or La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Td, A kind of elements or those mixture are expressed at least among lanthanoidses, such as Dy, Ho, Er, Tm, Yb, and Lu. The presentation ratios a, b, and c It is atomic % preferably and the soft magnetism alloy characterized by satisfying 50<=a<=70, 5<=b<=30, 10<=c<=30, and the relation it is unrelated a+b+c=100 can be applied. In addition, if it is the soft magnetism alloy of this presentation, since the high specific resistance of 400-1000micro ohm-cm extent is shown as specific resistance as this invention persons indicated on the JP,06-316748,A specifications previously, it can be used for the purpose achievement of the invention in this application.

[0017] It is shown by FedM'eOf as example of presentation 2 empirical formula. M' A kind of elements chosen from the group of Ti, Zr, Hf, V, Nb, Ta, and W or those mixture are expressed at least, and the presentation ratios d, e, and f are atomic %s preferably. The soft magnetism alloy characterized by satisfying 45<=d<=70, 5<=e<=30, 10<=f<=40, and the relation it is unrelated d+e+f=100 is applicable. In addition, if it is the soft magnetism alloy of this presentation, since the high specific resistance of 400 to 2.0x105micro ohm-cm extent is shown as specific

resistance as this invention persons indicated on the JP,06-316748,A specifications previously, it can be used for the purpose achievement of the invention in this application.
[0018] It is shown by T100-a-b-c-d-Xa-Mb-Zc-Qd as example of presentation 3 empirical formula. Fe, Co or both, and X T Both Si, and both [either or] At least one sort of elements with which M' is chosen from the metallic element group of Ti, Zr, Hf, V, Nb, Ta, Mo, and W, and Z express C, N or both, and at least one sort of elements with which Q is chosen from the metallic element group of Cr, Re, Ru, Rh, nickel, Pd, Pt, and Au. Moreover, in the aforementioned presentation, it is desirable to satisfy the following presentation ratio (atomic %). 0<=a<=25, 1<=b<=7, 0.5<=c<=10, 0<=d<=10. If it is the presentation of this example, since the high saturation magnetic flux density exceeding 1T is shown, it can be used for the purpose achievement of the invention in this application.
[0019] As example of presentation 4 empirical formula, T100-e-f-b-c-d-Sie-Alf-Mb-Zc-Qd, Fe, Co or both, and M T However, Ti, Zr, Hf, At least one sort of elements chosen from the metallic element group of V, Nb, Ta, Mo, and W and Z express C, N or both, and at least one sort of elements with which Q is chosen from the metallic element group of Cr, Re, Ru, Rh, nickel, Pd, Pt, and Au. Moreover, it is desirable to satisfy the following presentation ratio (atomic %). 8<=e<=15, 0.5<=f<=10, 1<=b<=7, 0.5<=c<=10, 0<=d<=10. If it is the presentation of this example, since the high saturation magnetic flux density exceeding 1T is shown, it can be used for the purpose achievement of the invention in this application.
[0020] Next, the ferromagnetic layer 31 for pinning has Cr-aluminum of high specific resistance most desirable [the layer] especially, although it is desirable to consist of the different antiferromagnetic substance, for example, Cr-aluminum, PtMn, NiO, etc. as for said antiferromagnetism layer 38.
[0021] In the aforementioned structure, since the soft magnetism layer 37 is formed on the free ferromagnetism layer 34, ferromagnetic association of the free ferromagnetism layer 34 and the soft magnetism layer 37 can be carried out, and, thereby, the coercive force of the free ferromagnetism layer 34 can be lowered. Furthermore, by forming the antiferromagnetism layer 38 on the soft magnetism layer 37, while being able to single-domain-ize the soft magnetism layer 37, bias can be impressed to the free ferromagnetism layer 34 by the single-domain-ized soft magnetism layer 37. Moreover, by the ferromagnetic layer 31 for pinning stuck all over the pinning ferromagnetism layer 32, pinning of the sense of magnetization of the pinning ferromagnetism layer 32 can be carried out, and the sense of magnetization can be arranged in the direction perpendicular to the space of drawing 1 of b. By turning the sense of magnetization of the free ferromagnetism layer 34 in the direction of arrow-head a of drawing 1 , and turning the sense of magnetization of the pinning ferromagnetism layer 32 in the direction of arrow-head b from the above thing, both can be made to be able to intersect perpendicularly at about 90 degrees, and can be arranged.
[0022] The stationary current is given to the magneto-resistive effect multilayers T1 in the structure shown in drawing 1 . If it is the structure shown in drawing 1 , as a result of carrying out pinning of the sense of magnetization of the pinning ferromagnetism layer 32 and freeing the direction of magnetization of the free ferromagnetism layer 34 in the field equivalent to the width of recording track TW, a coercive force difference arises among the ferromagnetic layers 32 and 34, it originates in this, and giant magneto-resistance is obtained. That is, if external magnetic fields, such as a leakage field from a magnetic-recording medium, act on the part equivalent to the width of recording track TW of the center section of the free ferromagnetism layer 34 where rotation of magnetization was freed, since the sense of magnetization of the free ferromagnetism layer 34 will rotate easily, resistance change arises in the magneto-resistive effect multilayers T1 with rotation, and the magnetic information on a magnetic-recording medium can be read by measuring this resistance change. Moreover, resistance change is obtained by good linearity responsibility, without producing a Barkhausen noise, since the free ferromagnetism layer 34 is in contact with the single-domain-ized soft magnetism layer 37 and vertical bias is moreover impressed in the case of this resistance change.
[0023] Moreover, in the structure shown in drawing 1 , when the ferromagnetic layer 31 for pinning is constituted from alpha-Fe 2O3, alpha-Fe 2O3 is oxide from the first, and it excels in corrosion resistance compared with FeMn used in the conventional spin bulb structure, and since Neel temperature is high, there is the description strong against temperature fluctuation. In addition, although it indicated that the ferromagnetic layer 31 for pinning could be constituted from alpha-Fe 2O3 in the component structure shown in drawing 1 , be [what is necessary / just since it seems that the component of the ferromagnetic layer 31 for pinning makes the magnetic switched connection force act on the pinning ferromagnetism layer 32, and makes coercive force high], of course, you may constitute from other antiferromagnetic substance, oxide antiferromagnetic substance, or high coercive force magnetic substance etc.
[0024] Next, in order to obtain the magneto-resistive effect multilayers T1 of the structure shown in drawing 1 , nonmagnetic ceramic substrates, such as aluminum2O3-TiC (Al Chick), are installed in the chamber of high frequency magnetron sputtering equipment or ion beam spatter equipment, and after making the inside of a chamber into inert gas ambient atmospheres, such as Ar gas, it can create by forming a required layer one by one. Targets required for membrane formation are for example, 2Oalpha-Fe 3 target, a nickel-Fe alloy target, a Cu target, etc.

[0025] In order to manufacture the magneto-resistive effect multilayers of the cross-section structure shown in drawing 1 Impressing a field at the Z direction of drawing 1 into reduced pressure ambient atmospheres, such as 3 or less mTorr of Ar gas pressure etc. While forming the ferromagnetic layer 31 for pinning which consists of alpha-Fe 2O3 on a substrate by the spatter and forming the two-layer ferromagnetic layers 32 and 34 on both sides of a non-magnetic layer 33 on this ferromagnetic layer 31 for pinning It leaves the part which is equivalent to the width of recording track with a photolithography process and ion milling, other parts are removed, and it considers as a layered product 35. If a layered product 35 is formed, the electrode layers 36 and 36 will be formed so that the both sides of a layered product 35 may be inserted, and the laminating of the soft magnetism layer 37 and the antiferromagnetism layer 38 is carried out so that the top face of a layered product 35 and the top face of the electrode layer 36 may be covered further. Membranes are formed impressing a field, when carrying out the laminating of the antiferromagnetism layer 38 here.

[0026] Subsequently, pinning of the sense of magnetization of the pinning ferromagnetism layer 32 is carried out by impressing a field to the space perpendicular direction of drawing 1 , magnetizing the ferromagnetic layer 31 for pinning, and fixing the sense of magnetization. The magneto-resistive effect mold sensor of the structure shown in drawing 3 the sense of magnetization of the pinning ferromagnetism layer 32 and 90 degrees of drawing 3 and sense of magnetization of the free ferromagnetism layer 34 crossed at right angles by the above processing can be obtained.

[0027] In the photolithography process in the case of forming a layered product 35 here, although processing which removes a garbage by ion milling and forms a layered product 35 is performed after carrying out the laminating of the required film and putting a wrap mask for the formation schedule part of a layered product in this cascade screen, it is possible that an undesired substance mixes in the flank side of a layered product 35 here at the time of ion milling. However, if it is the structure shown in drawing 1 , since the soft magnetism layer 37 and the antiferromagnetism layer 38 which are formed on the free ferromagnetism layer 34 will impress vertical bias to the free ferromagnetism layer 34, it is good to prepare in the flank side of the free ferromagnetism layer 34 only in the electrode layer 36, and, as for unnecessary element mixing by the side of the flank of a layered product 35, does not have a bad influence on a magneto-resistive effect at all. Therefore, even if it performs an ion milling process, a bad influence does not do to a vertical bias impression device at all.

[0028] next -- drawing 2 -- this invention -- starting -- a magneto-resistive effect -- multilayers -- the -- two -- a gestalt -- being shown -- a thing -- it is -- this -- a gestalt -- a magneto-resistive effect -- multilayers -- T -- two -- a cross section -- trapezoidal shape -- a layered product -- 40 -- pinning -- ** -- ferromagnetism -- a layer -- 31 -- pinning -- ferromagnetism -- a layer -- 32 -- a non-magnetic layer -- 33 -- free -- ferromagnetism -- a layer -- 34 -- soft magnetism -- a layer -- 37 -- ' -- antiferromagnetism -- a layer -- 38 -- ' -- from -- constituting -- a layered product -- 40 -- both sides -- hanging -- as -- an electrode -- a layer -- 36 -- 36 -- having prepared -- structure -- it is -- .

[0029] Drawing 3 is what shows the 3rd gestalt of the magneto-resistive effect multilayers concerning this invention. Next, the magneto-resistive effect multilayers T2 of this gestalt Form on a substrate by using the soft magnetism layer 37 and the antiferromagnetism layer 38 as a substrate layer, and carry out the laminating of the free ferromagnetism layer 34, a non-magnetic layer 33, the pinning ferromagnetism layer 32, and the ferromagnetic layer 31 for pinning, and a layered product 41 is constituted so that it may become cross-section trapezoidal shape on it. It is the structure which formed the electrode layers 36 and 36 so that it might hang on the soft magnetism layer 37 at the both sides of said layered product 41.

[0030] Since the laminating of the soft magnetism layer 37 and the antiferromagnetism layer 38 is carried out to the free ferromagnetism layer 34 also in which such structures, vertical bias can be impressed, since adhesion arrangement of the antiferromagnetism layer 38 is carried out at the soft magnetism layer 37, the soft magnetism layer 37 can be single-domain-ized, and the purpose of this application can be attained like the case of a previous gestalt.

[0031] In addition, since the layered product 40 is constituted from the ferromagnetic layer 31 for pinning, the pinning ferromagnetism layer 32, a non-magnetic layer 33, a free ferromagnetism layer 34, soft magnetism layer 37', and antiferromagnetism layer 38' unlike the structure it is indicated to drawing 1 that is the structure shown in drawing 2 It can manufacture by forming a layered product 40 by carrying out ion milling collectively, after carrying out sequential membrane formation and carrying out the laminating of the film for forming these, and forming the electrode layers 36 and 36. That is, since it is unnecessary like the structure shown in drawing 1 with the structure which the need of carrying out the laminating of the soft magnetism layer 37 and the antiferromagnetism layer 38 separately further shows to drawing 2 after forming a layered product 35 and the electrode layer 36, if it is the structure shown in drawing 2 , rather than the structure shown in drawing 1 , a routing counter can be reduced and it can manufacture easily.

[0032]

[Effect of the Invention] As explained above, this invention carries out the laminating of a soft magnetism layer and

the antiferromagnetism layer to a free ferromagnetism layer, and is prepared, and while making a soft magnetism layer produce magnetic switched connection from an antiferromagnetism layer and single-domain-izing a soft magnetism layer, vertical bias can be impressed to a free ferromagnetism layer through a soft magnetism layer from an antiferromagnetism layer. And since a soft magnetism layer and an antiferromagnetism layer are prepared in the form which carries out a laminating to a free ferromagnetism layer, even if it is the case where carry out the laminating of the film which constitutes each class, and patterning is carried out by ion milling etc., a possibility that an undesired substance may mix in the laminating interface of a soft magnetism layer, an antiferromagnetism layer, and a free ferromagnetism layer disappears, and can impress the vertical bias as the purpose. Therefore, if the magneto-resistive effect multilayers of said structure are used for the magnetic head, the magnetic head which carries out a linearity response and can read magnetic information for resistance change to a minute field from a magnetic-recording medium in a lifting and the condition that there is no Barkhausen noise with sufficient detection sensitivity by this can be offered.

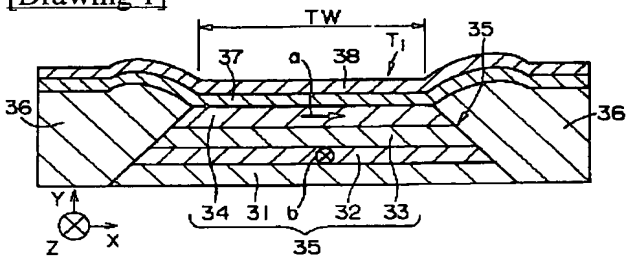
[Translation done.]

* NOTICES *

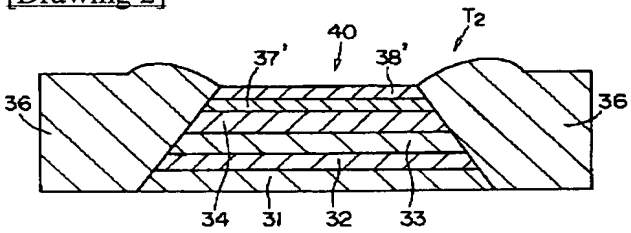
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

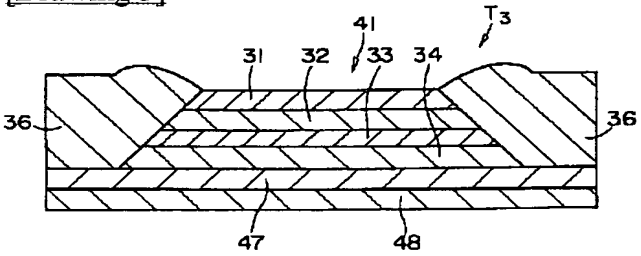
[Drawing 1]



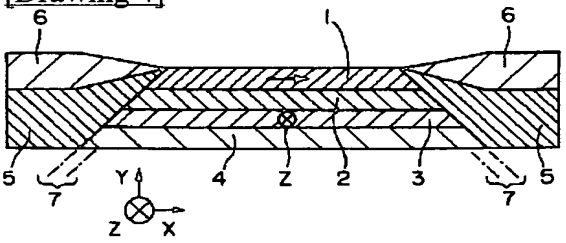
[Drawing 2]



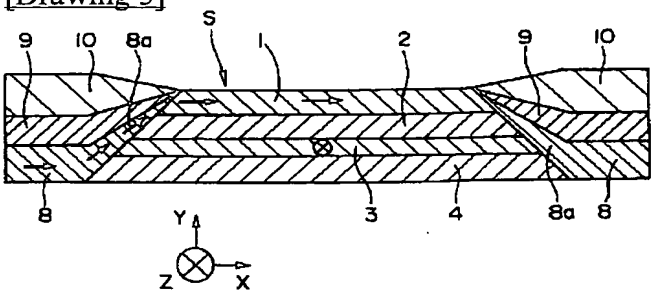
[Drawing 3]



[Drawing 4]



[Drawing 5]



[Translation done.]